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Preliminary Results of Post-Disaster Archaeological Investigations at the Vatsala Temple and within Bhaktapur's Durbar Square, Kathmandu Valley UNESCO World Heritage Property (Nepal)

Coningham, R.A.E.[1], Acharya, K.P.[2], Davis, C.E.[1], Kunwar, R.B.[3], Tremblay, J.C.[1], Schmidt, A.[1] and Simpson, I.[4]

[1] Department of Archaeology, Durham University, DH1 3LE, UK

[2] Former Director-General of Archaeology, Department of Archaeology, Government of Nepal, Kathmandu, Nepal

[3] Department of Archaeology, Government of Nepal, Kathmandu, Nepal

[4] School of Natural Sciences, University of Stirling, FK9 4LA, UK

1. Introduction

On the 25th April 2015, the 7.8 Magnitude earthquake that struck Nepal and neighbouring regions impacted greatly on the cultural heritage of Nepal, especially the Kathmandu Valley UNESCO World Heritage Property. A natural disaster of massive proportions, leaving thousands dead and hundreds of thousands homeless, the earthquake of the 25th April and the following earthquake of the 12th May, was also a major cultural catastrophe. The medieval Durbar Square of Bhaktapur was one of the major monumental core zones of the Kathmandu Valley UNESCO World Heritage Property that suffered damage as a result of these earthquakes. As part of a UNESCO sponsored mission, national and international experts from the Department of Archaeology, Government of Nepal, Durham University and the University of Stirling, conducted post-disaster archaeological surveys and rescue excavations at earthquake-damaged monuments and areas within the UNESCO Kathmandu Valley World Heritage Property, including within Bhaktapur's Durbar Square.

2. Earthquake Damaged Monuments in Bhaktapur's Durbar Square

The main Bhaktapur Durbar Square measures some 190 metres east to west, and between 20 and 30 metres wide, and covers an area of some 4,750 Square metres. Although incorporating a large open space, the Durbar Square was not always so empty of structures. Indeed, watercolours by Henry Ambrose Oldfield in 1853 and 1858, as well as early photographs of the eastern edge of the Durbar Square, show the presence of a major facade, often obscuring the eastward view of the Vatsala Temple. This two-storied building, a *sattal* or resthouse, collapsed in the 1934 earthquake and was not rebuilt. Korn notes that this building, the Lamupati, was utilised as a *dharmasala* for the military (2007: 85) and his plans of the Square trace its original position (ibid.: 86). Gutschow's plan also shows its original outline with a postulated date of c. 1750 for the erection of the building (2015: 78) – he also cites Rajman Singhe's 1844 record of the building as the "The Lam Pati or Chief Court of Justice" (ibid.: 82). Singhe's pencil drawing depicts a long north-facing façade defined by a raised ground floor veranda supported by 22 wooden pillars on stone pillars and fronted by a lower brick plinth (ibid.). These early illustrations also indicate the nature of surface of the squares with Oldfield's paintings suggesting the widespread use of bricks or tiles (ibid.: 79-81).

The layout of Bhaktapur's Durbar Square was dramatically remodelled after the 1934 Bihar earthquake and some monuments were never rebuilt. For example, the Lamupati was never reconstructed and the main portion of the Durbar Square is now a more open space. To the east and south of the Fasu Dega Temple, all that remains of the Hari Shankar Temple are the entrance lions as the rest of the structure completely destroyed. Although photographic evidence is available of this structure pre-1934, the monument was never reconstructed and it has been suggested that this was due to the probability that the statue of the main deity was lost (UNESCO 2015: 40). More recently, it has been reported that the Municipality was considering the total reconstruction of this temple based on photographic records, even though it has been noted that there is insufficient detailed documentation to carry out a proper reconstruction (ibid.). Such plans may now have changed in light of the aftermath of the 2015 earthquakes.

Other Bhaktapur monuments have been targeted for reconstruction and the octagonal Chyasilin Mandap was rebuilt 26 years ago. After its original collapse in the Bihar earthquake of 1934, much of the debris was cleared away with some of the roof struts reincorporated in the arch at the eastern end of the New Road in Kathmandu. Thought to date to the late seventeenth century, the monument was reconstructed in 1990 utilising some original elements that had been stored (Hutt 1994: 129). The rebuilding of the Chyasilin Mandap was guided through the use of historic photographs and combined traditional materials with a steel frame and reinforced concrete foundations. Due to this hybrid mixture of traditional and modern materials, some observers have noted that whilst

“The Mandapa itself has very little that could be called authentic, however it does contribute to recreating a part of the original (pre-1934) identity” (UNESCO 2015: 7).

Many structures in Bhaktapur have displayed, or to some degree do still exhibit, traces of the hasty renewal of buildings after the 1934 earthquake. For example, the original reconstruction efforts of the ‘55-Window Palace’ contained modifications that did not replicate the pre-earthquake structure. Attributed to 1697 CE and the reign of Bhupatindramalla (r. 1696-1722 CE), the top floor of the structure was destroyed in the 1934 earthquake. The initial post-1934 restoration had been rapid and wooden elements that were reincorporated were not placed in their original positions, diverging from to traditional construction practices, leaving the windows with less projection. Only during later restoration were these architectural elements rectified (ibid.: 40).

Other monuments were reconstructed in an entirely different design from that of the original collapsed monument. The most striking example of this is the Silu Mahadev, or Fasu Dega (Tahacho Dega) Temple. Located to the north-east of the Durbar Square, north of the entrance lions of the Hari Shankar Temple, all that survived of this monument after the 1934 earthquake was the monumental five-stepped plinth, which includes stone sculptures of elephant guardians, with lion and bull sculptures on the steps above. To protect the deity, a hasty shelter was erected, although this did not follow the traditional Newari form but was in a Neo-classical style with plasterwork and a dome with floral motifs following a style popular during the Rana period (UNESCO 2015: 40).

The Neo-classical shelter of the Silu Mahadev completely collapsed during the 2015 earthquake and, much like the post-1934 situation, the five-stepped plinth survived relatively unscathed (Figure 1). A portion of a structure to the south of this temple also collapsed (Figure 2). Furthermore, many monuments have visible signs of damage, including the brick sikara of the Siva temple, located in the west of the Square. Many of the structures of the palace complex were also damaged, particularly the building complex that now houses the National Museum of Art, which provides the Durbar Square with its northern edge, and is currently supported by wooden props. In the 2015 earthquakes, the most visible loss with the Durbar Square was the superstructure of the Vatsala Temple (Figures 3 and 4). Before discussing this Temple in detail, it should also be noted that the monuments of the Square did not suffer as much catastrophic damage as the vernacular settlement of Bhaktapur, with many properties damaged and destroyed. One of the major risks to its heritage is the loss of traditional architecture if these residential structures are rebuilt using modern material and styles.

3. Archaeological excavations at the Vatsala Temple and Bhaktapur’s Durbar Square

The Vatsala Temple is located in the south-east of Bhaktapur's Durbar Square to the south of the Palace complex. Oriented to the west, it is abutted on the north by the Telaju Bell of King Ranajitmalla (r. 1722-1769 CE) with its inscription of 1737 AD (Basukala et al. 2014: 29) and stands a few metres to the west of a *hiti* and a few metres to the south of King Bhupatindramalla's column (r. 1696-1722 CE). One of three sikara temples in the main Bhaktapur Square, it is dedicated to Vatsula Devi, a form of the goddess Durga. It is generally agreed that the first monument dedicated to Vatsala was constructed by Jitamitra Malla (r. 1673-1696 CE) in 1693, with a second completed by the same benefactor in 1696 CE (Hutt 1994: 127, Basukala et al. 2014: 33). The present sandstone-built monument was completed by Bhupatindramalla (r.1696-1722 CE) and most scholars agree to a construction date of between the late seventeenth and early eighteenth century CE with a rededicated bell stand in 1721 CE (Korn 2014: 29-33, 44, Basukala et al. 2014: 33). Apart from epigraphic evidence and accounts within local Chronicles, "Nothing more is known about the history of the temple" (Basukala et al. 2014 :33).

During the 1934 Bihar earthquake, half of the Temple's sikara tower collapsed. Although reconstructed, damage caused by the growth of a pipal tree led to the Department of Archaeology, with support from UNESCO and the technical guidance and assistance of Wolfgang Korn, undertaking a program of conservation between 1977 and 1978 (Korn 2014: 37, Basukala et al. 2014: 33). This work included the dismantling of the northern portion of the tower as well as two corner pavilions, with the replacement of a lintel above the arcade and the stone blocks of the tower reset in cement mortar (Basukala et al. 2014: 33). Indeed, many of the large fragments of the stone sikhara lying in the Durbar Square are still joined by the thick mortar and bricks, some with visible mason marks engraved in Roman script.

Korn has recently provided some detailed measurements for the visible parts of the Temple's superstructure, recorded in 1977 and 1978 from scaffolding erected for the monument's repair (2014: 37). Korn states that the monument "was built in stone" and comprised a 12.85 metre high temple above a 0.6 metre high platform which itself stood on a triple-stepped plinth 2.25 metres" (ibid.: 44), although he also records that the latter is 2.75 metres elsewhere (ibid.: 68). The staircase descends to the west and has a stone balustrade formed by a pair of elephants with a pair of lions above. Little has been written about the monument's foundations but Korn has recently suggested more broadly of the stone-built temples of the Kathmandu Valley that "it can be assumed that the lower layers of the foundations are made of boulders or lumps of coarsely worked stone" (Korn 2014: 60). Such an assertion has now been illustrated through systematic excavations at the Char Naryan Temple in Patan Durbar Square (Coningham et al. 2016a) and was a very real possibility at the Vatsala Temple.

Excavations began at Bhaktapur's Durbar Square on the 7th November 2015. Following the initial GPR results, which suggested the presence of several anomalies, most likely walls running below the Durbar Square (see Section 5), we laid out a trench that was one metre wide and 15 metres east-west, from south of the main steps of the west-facing elevation of the Vatsala Temple. The trench then formed a right angle and ran 15 metres north-south, again with a width of one metre (Figure 5). This right angled trench was termed Trench 1 and was laid out in this way to investigate and identify potential archaeological features picked up in GPR survey (see Section 5). A deep trench was also proposed, which was 1.20 metre east-west and three metres north-south, running alongside the southern portion of the west-facing elevation of the Vatsala Temple. This deeper trench that was partially within the original footprint of Trench 1 was designated as Trench 1A. To the north of the steps of the Vatsala Temple's west-facing elevation, we also cleared rubble and loose material from the lowest plinth of the temple, which had been damaged by the earthquakes of 2015. This area of investigation at the temple was designated as Trench 1B.

Trench 1

The majority of modern paving within Trench 1 was constructed from bricks laid on edge in a herringbone design, although in certain locations other patterns of brick were present. For example, the presence of a square alignment of bricks containing a herringbone pattern, representing a ritual marker reduced the length of the north-south section of the trench to 11.5 metres. With the exception of the ritual square, this modern brick paving was removed onto a thin layer of cement in which the bricks had been laid. This cement was removed onto portions of modern brick within a loose sand, laid as a setting for the construction of the contemporary paving. Cutting through these brick settings and running north-south were three modern pipelines, identified on the Ground Penetrating Radar Survey (see Section 5), within a cut filled by mixed materials. These pipelines truncated earlier archaeological stratigraphies, illustrating the necessity for archaeological assessments and archaeological watching briefs before any intrusive digging across the Durbar Square or any site of historic and archaeological importance by highlighting the damage to subsurface heritage through unchecked below ground intervention during the laying of amenities and services. The modern cut also formed the eastern boundary between Trench 1 and Trench 1A.

The modern brick settings were placed on top of a sandy clay levelling deposit, which was thicker to the right angled southwest corner of the trench, where the brick setting was missing. Once the brick settings and sandy clay levelling material was removed a further paved surface was uncovered. Similar to the contemporary paving of the square, this was constructed from bricks laid on edge in a herringbone pattern (Figure 6). We believe that this represents the paved surface that was laid in the square shortly after the 1934 earthquake due to features identified below. Cut into this paving were several postholes, which were all patched over with brickbats and silt to reform the temporarily damaged paved surface. This suggests that temporary structures were erected on the Square and again demonstrates that even seemingly open areas of the Durbar Squares in the Kathmandu Valley can be transformed by temporary structures, often linked to intangible events.

This earlier brick paving was removed onto a thin sandy clay levelling material, which was found throughout the trench, apart from in the northern most five metres of the north-south length of the trench where a cement material was utilised for levelling. Both these deposits appear to be some form of levelling prior to the laying of the brick paving that they are both respectively sat below stratigraphically and it may be that the distinction between the two materials related to the archaeological features identified below. Within the sandy clay levelling, two features formed from sand were apparent, which were excavated onto the top of brick and it became clear that the sand was not the result of the filling of cuts but was deposited to fill gaps during the process of levelling, especially over pre-existing brick features, presumably cleared and levelled after the 1934 earthquake.

The removal of all levelling material revealed several pre-1934 earthquake archaeological features. Below the 1934 paving and levelling were several alignments of brick running north-south as well as east-west across the trench (Figures 7 and 8). This included a feature formed by two rows of regularly laid brick running north-south. Initially, thought to be a wall due to its core being formed from more irregular brickbats, this fill was removed onto irregular placements of tile and brick. With the two regular rows of brick only two courses deep, it was reinterpreted as a drain with the brickbat a tile deposits possibly representing the later infilling and levelling of a drain when it was no longer in use. To the east of this drain was a one course thick brick paving, which was adjacent to a shallow pit, which was filled by a charcoal and bone rich material.

Also running north-south across the trench, was a defined surface of smaller squared bricks. Again, initially thought to be a wall, excavation revealed that this feature was one course thick and actually represented another paved area (Figure 9). Several walls were identified in the trench that also ran on a north-south alignment. To the east of the paving and west of the drain were two wall alignments, very close together. Due to their proximity and the leaving of the walls in situ during this pilot season, we could only identify eleven courses of brick, but several more were probable. We also identified potential signs of penetrative fractures or shear cracks within the west-facing elevation of the more western wall (Figure 10), which is one of the key classifications of Earthquake Archaeological Effects (EAW) that can be identified in the archaeological record (Giner-Robles et al. 2009: 13). The wall to the east of this appeared to be cracked and had a split running north-south across the alignment. The wall was titled and displaced to the east and also was associated with a brick scatter, probably relating to a wall collapse (Figure 11). These indicators on these two walls suggest evidence of damage caused by earlier earthquakes, most likely relating to the events of 1934.

Six walls were also identified running east-west across the trench. Constructed of brick, although the northernmost was constructed on stone foundations, these walls sat within extremely narrow cuts. The furthest south of these walls appeared to have a cut relating to a wooden post, and also appeared to be robbed out to its east. The east-west walls all appeared to cut through a very clean yellow clay material. Initially thought to be a potential natural, the material resembled a prepared floor surface. We await geoarchaeological results of both the micromorphology and scientific dating before confirming such a hypothesis, thought it would appear to be earlier due to the intrusive nature of the wall cuts.

All these masonry features in Trench 1 were roughly the same level, suggesting that either they were all levelled at a similar time, most probably in relation to the reconfiguring of the main Durbar Square after the 1934 earthquake, or they were constructed at a similar time for the same structure. It is possible that the walls on east-west alignments may be of differing phases but, due to the close nature of some, they may also have supported slots for timber sleepers to create verandas. We await the results of scientific dating before we can confirm these hypotheses. The identification of walls and paving, as well as associated archaeological features, is not surprising in this area of Bhaktapur due to the evidence from historic photographs and paintings by Henry Ambrose Oldfield that illustrate structures within the Durbar Square which were then not rebuilt after the 1934 earthquake in the same locations as discussed in Section 2 above. The excavations also demonstrate the subsurface heritage below the current Durbar Square's paving and the need to protect it from intrusive interventions through Archaeological Risk Maps, watching briefs and archaeological recording.

In addition to the wall alignments, some negative features also cut through the possible prepared yellow clay surface, including a large negative feature just east of the return at the right angle of the trench. To the east of the feature was what appeared to be a rubble spill overlying some large stones, which might represent the surviving portion of a robbed out wall footing. This possible footing was left in situ, and the upper fills of the negative feature, which comprised fairly homogenous mixed deposits that may have been related to post-1934 levelling deposits, were removed. Next, silty clay deposits were removed onto a mottled yellow clay. This clay sealed a very sandy greyish green deposit, which contained lenses of clay. Once removed, these deposits revealed a series of bricks laid on edge, which followed the slope of the cut. Also following the slope of the cut was a brick paved surface, which was also left in situ (Figure 12). The angles of these brick surfaces, and the deposits that overlaid them may suggest that this negative feature was a drain cut through the Durbar Square. However, due to the narrow nature of the trench it is difficult to corroborate such assertions. To fully investigate the nature of this feature and the relationship between this and all the wall alignments that were identified, future open area excavation is required.

Whilst the excavations in Trench 1 illustrated the complex archaeological remains below the current Durbar Square, including durable and non-durable features, the excavations did not provide a deep sequence or provide any insights into the nature and condition of the foundations of the collapsed Vatsala Temple. To assess these foundations, a deeper Trench 1A, was opened adjacent to the west-facing elevation of the surviving Temple plinth.

Trench 1A

Trench 1A measured three metres north-south alongside the western elevation of the Vatsala Temple to the south of its central steps, and was 1.20 metres in width east-west. The west-facing elevation bore the marks of recent earthquake damage with some of the worked stone blocks missing, shaken from their setting. From those that remained, it was clear that the stone blocks formed a stone cladding over a brick core and that this cladding was not keyed together or keyed into the underlying brickwork. Indeed, the stone blocks were not mortared to each other or the brickwork below. As in Trench 1B (see below), it became clear that the stone cladding had been cut to allow for its later placement over the bricks, suggesting two quite separate phases of construction. The stone blocks were levelled above the brickwork through the use of a pale loose silt.

The western edge of the trench was defined by the modern pipeline cut running north-south but also defined by the step down in the modern paving of the Durbar Square adjacent to the Vatsala Temple. The contemporary brick surface was removed onto cement, which had been thinly skimmed over irregularly laid modern brick setting for the paving above, which was within a sand deposit. Once this brickwork was removed, it revealed a deposit of sandy silt levelling, which covered the top of a brick alignment that stepped-out below the current above ground profile of the Temple. In addition to stepping-out, this brick alignment did not follow the same footprint of the current Temple, which in fact overhangs this lower alignment to the south (Figure 13). Again, this suggested the presence of two quite separate phases of construction.

This lower stepped-out brick alignment did not run all the way to the central steps of the west-facing elevation in the north of the trench but was cut by a wide and deep post hole. It is hypothesised that the cut through this brickwork was for a large wooden post that may have been associated with a temporary structure, potentially a pavilion, adjacent to the Temple, or to form a more permanent non-durable edifice to the Vatsala Temple frontage. Due to the location of the now collapsed bell on the southern portion of the Temple frontage, it is possible that this cut represents where the post for an earlier bell may have been erected. The cut was differentiated as it was filled with a lighter looser soil and contained large stone fragments, large brickbats and bricks. This fill either related to the original packing for the wooden post or was from a later episode of levelling in front of the Temple, possibly related to the construction of the current brick core and stone cladding of the most recent Temple.

Several deposits were found below the levelling deposit, suggesting past human activity. These included thin charcoal and ceramic rich surfaces and also mottled deposits that contained charcoal, brickbats and ceramics. Cut into these horizons of activity were several negative features. These included a large circular clay feature, which itself was cut by a smaller posthole to its north, which contained a dense packing of brickbat material. The large clay circular deposit was actually the top layer of several materials sitting within the same cut. Below the clay was a surkhi and brickgrits deposit (Figure 14). This was then removed onto a grey compact clay, which itself overlaid a bright red brickdust deposit (Figure 15). Once removed, this revealed a divoted undulating surface and was left in situ and unexcavated.

To the north of this a sub-circular cut, with several fills, was another feature cut into the same activity horizons. Initially, a greyish brown sandy silt covered a large natural piece of stone (Figure 16), which was placed on top of a brick packing. This brick packing laid over several large natural stones, which were placed on a heavily degraded thin flat stone. At present, it is unclear what these two negative features may represent but further excavation and continued artefactual analysis will aid our understanding of the function, use and character of these features. Presently, we suggest that the feature towards the south may relate to the mixing of materials for the construction of the later developments of the Vatsala Temple or nearby structures. The feature to the north may be a large post-pit of some description but it is not clear what this feature relates to and further investigation, including excavation of the area around this feature, is required. Whilst the function and purpose remains unclear, it is apparent that these features do demonstrate the wealth of sub-surface heritage under Bhaktapur's Durbar Square and the need to protect it from intrusive interventions. Leaving the cuts of these negative features in situ, a slot was opened one metre in length from the south facing section by 1.20 metres east-west. This allowed the sampling of a deeper sequence, including the exposure of the foundations of the Vatsala Temple itself.

After the removal of a greyish brown cultural deposit containing brickbats ceramics and charcoal, brown clay deposits that were sterile of cultural material were encountered. There were several horizons of soils devoid of cultural material and it is thought that these levels reflect pre-human activity at the site, representing natural soil profiles and accumulations. Some of these soils that were thought to be natural appeared to have enhanced mottling through periodic wetting of the soil. The deepest soil encountered was a dark greyish brown clay devoid of cultural material. These deposits were found next to the foundations of the Vatsala Temple. Resting at the same level as the surface of the deepest greyish brown clay, were the stone cobble foundations of the Temple (Figures 17 and 18). In places, three courses of stone cobbles were visible and these varied in size and were placed fairly irregularly. Similar to the construction technique of foundations identified at the Char Narayan Temple in Patan (Coningham et al. 2016a), it also partially confirms Korn's hypothesis for sikara style temples that "It can be assumed that the lower layers of the foundations are made of boulders and lumps of coarsely worked stone" (2014: 60), although as will be outlined, these only formed a few courses and were mainly constructed of brick. Set above these cobbles were irregular foundations of the Temple, comprising eleven courses, the bricks were not of a standardised size and, in some rows, stone cobbles were present. This phase of walling seemed to bulge out towards the west. Placed on top of this foundation was more regular brickwork, which formed the step-out described above, below the current Temple exterior wall, and which was cut by the possible earlier bell post. No cut was visible for these phases of foundation and temple walling and it is possible that the wall was placed in an exceptionally narrow cut, hence the poorly laid nature of the masonry and cobbles, and possibly why portions of the foundations bulged to the west. What is clear is that there were several phases of construction at the location of the Vatsala Temple and that the protection of the monument also needs to encompass the substantial subsurface remains below its most recent construction.

Trench 1B

Trench 1B related to the clearing of loose material from the lower stone plinth of the Vatsala Temple, to the north of the central steps in the west facing elevation. Below the loose worked stone blocks was a pale loose clay, which contained small chipped fragments of stone that we believe are from the working of the blocks. The large stone blocks were not keyed into each other or the underlying brickwork, which formed the core of the Temple walls. The stone blocks were not keyed into the brickwork behind but were bonded to it through the use of clay mortar, which again contained fragments of chipped stone. Therefore, it became apparent that the stone blocks formed a later facing to the Temple's brick core and that the blocks had been brought to the site and cut to fit the brickwork rather than the other way. It would appear that the fragments of chipped stone incorporated into the clay mortar separating the two were most likely from this in situ working of the large stone block cladding. The later addition of stone cladding was further supported by the observation that the loose clay was not evenly spread but was found in denser and deeper concentrations over the underlying brickwork and that the thickness of the stone blocks were also not even, with different sized blocks used in tandem with this clay fill to provide a level surface for the stone facing (Figure 19).

It is of note that a rim fragment of copper alloy was recovered from the loose soil within Trench 1B. The rim size indicates that it was similar to one of the copper alloy bells hanging from the debris recovered from the collapsed Vatsala Temple. Indeed, Korn records that "the temple (Vatsala) was ornamented by 23 small bells on each side under the overhanging apron" (2014: 44) and it is highly likely that this copper alloy piece represents a fragment from one of these bells that was damaged during the earthquake of 25th April 2015 (Figures 20 and 21).

4. Geoarchaeological Analysis at the Vatsala Temple and Bhaktpaur Durbar Square

As is clear from this report, the UNESCO-sponsored post-disaster phase of archaeological assessment has not only provided information for engineers and architects as to the design and nature of the structure's foundations, it has also offered a unique opportunity to develop new understandings of the early landscapes on which monumental structures were superimposed. Working from the well-established premise that fossil (buried) soils and sediments retain records of past cultural and natural environments, the team undertook geoarchaeological analyses on stratigraphies underlying the collapsed Vatsala Temple and current Durbar Square. By endeavouring to read these stratigraphies, our purpose is to give new understandings of the ways in which the globally significant site of Bhaktapur formed and, in doing so, we anticipate enhancing our understanding of the Outstanding Universal Value of this site.

Working with site stratigraphies exposed by archaeological investigations and minimizing site intrusiveness, our analyses commenced with geoarchaeological-based field descriptions using Munsell colour (including mottle colours), texture (particle size and sorting), structure (soil organization), and frequency of cultural inclusions (in this setting primarily fine charcoals, brick and pottery fragments). We have extracted Optically Stimulated Luminescence (OSL) samples for scientific dating, and also Kubiena tins for micromorphological analysis of microstratigraphy. Whilst we are still undertaking our analyses of the samples, some preliminary observations can be made about Bhaktapur.

One of the most striking features of the stratigraphies at Bhaktapur is the distinct transition from sediments with common charcoal frequencies in the lower part of the stratigraphy to sediment dominated by brick inclusions. We currently interpret this as a transition from rural to urban landscapes. We hypothesise that the limited charcoal content of the lower contexts is associated with background burning and management although the sites themselves were set apart from everyday domestic activity. At Bhaktapur, this was a largely unchanging environment with sediment accumulation, the result of persistent low-level wind erosion. Transitions from rural to urban landscapes are characterized by rapid changes in environmental conditions with some indications of increased wind erosion at Bhaktapur and short-term switching from rapid to slow river flows. Based on frequency of brick fragments, our observations also indicate that there may have been phases of urban activity with persistent intensification of urbanisation.

To further test these observations and provide chronologies for the stratigraphies and their interpretation, we have used our field observations as a framework for geoarchaeological sampling Chronological frameworks will be based on OSL dating; we have collected tube samples for luminescence measurement together with associated background environmental dose rates in the field. It is anticipated that we will be able to date the onset of rural landscape activity and the transitions from rural to urban settlement. This latter set of analyses will allow is to relate this transition to wider, regional, changes in climate, testing our observations that urbanisation appear to have emerged in a period of fluctuating environmental conditions that may be the result of climate change or the process of urbanisation itself. Undisturbed samples have been collected in Kubiena tins for quantitative thin section micromorphology analyses together with on-slide EDX analyses to give chemical element assessment of key features. This together with associated bulk analyses for particle size distribution of the transition phases will give a reading of the stratigraphies that characterises the intimate relationships between cultural and natural environments as they evolve over time.

Excavations at Bhaktapur have also demonstrated a complexity of brick foundation walls relating to earlier structures and construction phases. The disentangling of the chronologies of these foundation walls is now being undertaken with geoarchaeological investigation using an integration of OSL dating and thin section morphology with particle size distribution analyses to characterise the sediments being dated. At Bhaktapur, we are working on dating the surfaces beneath the walls, fill material that has been added to close cuts where walls have been inserted or used to fill larger foundations spaces, and wall brick itself. Our assumption is that underlying surfaces, infill material and brick will give the same dates for a particular wall and our sampling will permit triangulation of dates to optimize accuracy. In undertaking micromorphology and particle size distribution analyses, we will quantitatively assess the degree of similarity between the fill materials together with the degree of preparation of underlying wall surfaces as a way of determining whether walls are associated with different cultural sedimentary environments and thus of likely different ages. The triangulation approach adopted here will be the first comprehensive approach to wall dating in medieval and later urban sites in the Kathmandu Valley. Although we are still processing the samples, preliminary results suggest that the foundations of the earliest brick structure underlying the later stone Vatsala sikara Temple may be as early as the first century BCE. These are tentative dates and may change in future after further analysis, although at present they do suggest that some of the earliest construction at the Vatsala

Temple site is far earlier than the current attributions of a seventeenth or eighteenth century date.

5. Ground Penetrating Radar Survey

As stated above, Ground Penetrating Radar Survey (GPR) was conducted over the majority of the main Durbar Square at Bhaktapur (Figures 22, 23 and 24). The most clearly visible modern anomalies are in the western part of the Square, where several linear lines cross in various directions. All these elongated linear anomalies are either pipes or electricity cables. Some link the metal man-hole covers that are visible on the surface. The majority of these linear anomalies show as “white” lines in the GPR data, representing areas of low reflection and are hence interpreted as the trenches that hold the respective utility lines. In the eastern part of the Square, just west of the Vatsala Temple, there are two narrower linear low-reflection anomalies. By analogy with the results from the western part of the square, these could also be utilities. From our excavations we have shown that those running north-south past the Vatsala Temple are indeed metal pipes.

The main part of the square contains a large number of anomalies of probable archaeological origin. This assessment is based on their shape and size. Many linear anomalies are aligned in a rectilinear grid pattern and appear to have the width of a wall (c. 0.3 metres). Their shape and overall layout suggest wall foundations for a building that may have stood in this place, as is indicated by the well-known watercolour depiction by Henry Ambrose Oldfield and is confirmed in the areas opened during the season of archaeological excavations. In addition to these walls, many blocks of strong reflection are located throughout the area. Those inside the walls are of mostly rectangular shape and some specific feature inside the rooms are hence likely, for example, foundations to support a superstructure or subterranean storage areas. Further to the north, the block-anomalies take on a more irregular shape. A possible explanation may be that some of these could be large stones that were used as part of the levelling of the square. As stated, our excavations have uncovered some of these walls and features, but further investigation is required. This includes deeper excavations and further GPR data processing, to ascertain whether earlier structures are also present, a possibility from deeper wall-like anomalies visible in the data.

There are additional strong reflections from structures in the north-western part of the survey area, between the guardian lions and the western wall of the police compound. The upper level of these structures is strongly disturbed by the utilities but they extend over a considerable depth range, starting right under the paving and extending down to 1.8 metres depth. They may be the remains of a structure that originally stood there, again perhaps levelled after a previous seismic episode and sealed under paving, which is suggested by the outline of a lost building footprint in a similar location in plans of Bhaktapur's Durbar Square (Hutt 1994: 122, Basukala et al. 2014: 29).

The GPR survey has highlighted many archaeological features below the current paved surface of the main Durbar Square in Bhaktapur. There is therefore the potential that earlier phases of occupation are also present below other squares within Bhaktapur, including the Taumadhi Tol, Tachapal Tol and the Dattatreya Squares. GPR survey at these sites would aid the development of Archaeological Risk Maps, especially at the Dattatreya Square, where there is currently temporary occupation, where potential heritage can be identified and protected from further development and intrusive interventions to safeguard its subsurface heritage of Outstanding Universal Value.

6. Provisional Archaeological Risk Map of Bhaktapur Durbar Square

The archaeological investigations at the Vatsala Temple and within Bhaktapur's Durbar Square have illustrated the extent of subsurface heritage at this World Heritage site. The GPR survey has highlighted areas of potential archaeological features below the current square and excavations have revealed the character of some of these signatures. Bhaktapur provides the best exemplar of the changing nature of the layouts of Durbar Squares within the Kathmandu Valley. Bringing together historical research, including analysis of photographs, paintings and sketches of the Durbar Square, combined with archaeological investigations, it is clear is that the Durbar Square was not always an open space and has a complex history of development. The current square is not the original configuration, but is the most recent configuration of an organic and opportunistic development, relating to earthquake damage and the building programmes of the past.

The GPR and excavations clearly show the historic structures within the square, which lay below the current brick paving. Unfortunately, our investigations have also shown that one of the key features identified were modern pipelines running through the square, which we have clearly demonstrated have cut through earlier archaeological stratigraphy. Due to the high concentration of subsurface heritage at Bhaktapur, such modern interventions are a concern as the laying of any infrastructure has the potential to damage and destroy subsurface heritage of this site of Outstanding Universal Value.

The damage caused by the 2015 earthquakes will require reconstruction and also the repair and laying of amenities in Bhaktapur. Whilst we do not recommend the suspension of the laying services and reconstruction, we do advocate the mobilisation of rescue archaeology teams to undertake rescue excavations in advance of interventions (Coningham et al. 2016b). The Archaeological Risk Map for Bhaktapur will provide information for site managers and stakeholders for the risk posed to subsurface heritage and help guide future development (Figure 25). From our observations and investigations, we feel there needs to be a heightened awareness that the cultural heritage of Bhaktapur is not restricted to its standing remains but needs to take account of the deep foundations of these monuments and also the dense concentration of earlier phases of cultural activity found below the current brick paving of the main Durbar Square. The Archaeological Risk Maps and our interventions should facilitate the development of this awareness and protect subsurface heritage whilst not being of detriment to reconstruction.

7. Discussion and Conclusion

The archaeological investigations have demonstrated the complex development of Bhaktapur's Durbar Square and the pilot fieldwork provides a valuable case-study in the illustration of the changing nature of the urban centres of the Kathmandu Valley. Rather than representing monumental cores laid out in a single configuration from their establishment, our research shows that monuments were erected and removed over time, in some instances in relation to opportunism and ease relating to natural disasters, such as the 1934 earthquake. This levelling of damaged structures below public squares is not unique to the Kathmandu Valley but is also recorded in twelfth century Italy at the Piazza Duomo, where damaged structures were levelled and then sealed below the paved surface of the square in the reconstruction programme after an earthquake in 1117 CE (Forlin and Gerrard in press).

In Bhaktapur, this process was much more recent and these lost monuments are within the consciousness of historians, architects and archaeologists from their record in photographs and paintings from the nineteenth and early twentieth centuries. However, such knowledge has not averted intrusive interventions that have substantially damaged the subsurface heritage of Bhaktapur. Our excavations clearly show modern pipelines cutting through archaeological stratigraphy, which is of concern due to the nature of the durable and non-durable remains that are located below the current paved surface of the square. Furthermore, the GPR survey has illustrated that there is potentially a high density of earlier structures and archaeological remains across the entire Durbar Square. The pilot investigations at Bhaktapur illustrate the potential detriment to heritage that unchecked development could cause. This reaffirms the need necessity for archaeological assessments prior to any development or construction work at the site. The provisional Archaeological Risk Map provides guidance for any development and reconstruction that may occur in the Square, and we will continue to refine this map through further processing of the GPR data and any future archaeological investigations at the site.

In terms of research, whilst the small-scale excavations and GPR at Bhaktapur have demonstrated the presence of earlier structures across the square, we were only able to partially expose those structures nearest the surface. It is recommended that the opening of a larger excavation trench within our L-shaped trench from this recent mission would provide a full architectural plan of the building partially exposed. It would also be possible to sink deeper trenches within this to try and identify potentially earlier phases of structures that were postulated from the GPR data. This would allow further scientific dating and geoarchaeological investigations, which would aid our understandings of which structures and wall alignments were contemporary and associated. Looking towards future post-archaeological interventions, there is the possibility to mark subsurface alignments of walls in different brick patterns, as seen at Jarrow monastery in the UK (Figure 26), which would serve to inform visitors as to their courses as well as remind visitors as well as Municipal professionals and contractors as to their presence underneath their square.

The excavations on and adjacent to the Vatsala Temple in Trenches 1A and 1B have provided an understanding of the construction technique and phasing of the monument as well as some reasons as to why the monument may have collapsed in the earthquake of the 25th April 2015. Once loose material was removed, it was clear that the stone blocks were only cladding, not keyed in or mortared to each other or the underlying brickwork and belonged to a later construction phase. Currently, we cannot ascertain whether this was relatively soon after the construction of the brick core or sometime after but the evidence points towards two quite separate phases. This lack of bonding and the weight of stone blocks for the cladding possibly left the Vatsala Temple open to the displaced masonry earthquake damage. Indeed, unlike many monuments that were damaged in 1934 and not in 2015 or vice versa, the Vatsala Temple has now been badly damaged in both seismic events, suggesting a structural flaw in the interface between the monument's superstructure and foundations.

The deep excavations have also provided a sequence for the Vatsala Temple site, uncovering earlier phases that had not been previously known as well as providing information on the construction of the foundations and the background environmental development of Bhaktapur. The brick foundations of the Vatsala Temple rested on cobbles, similar to those identified at the Char Narayan Temple in Patan (Coningham et al. 2016a) and postulated by Korn (2014: 60). Our investigations have also identified at least three phases of brick construction, with a later stone phase, again illustrating the constant development of monuments, rather than the static, seemingly never changing, standing monuments that we see in the square today. They also demonstrate the depth of subsurface heritage below the architectural remains that are visible above ground (Figures 27 and 28). The provisional OSL dating of the initial Vatsala Temple site construction to the first century BCE highlights that earlier monumental phases are present in the Kathmandu Valley and that these subsurface features need to be protected so that they can be studied, analysed, recorded and most importantly preserved and protected for future generations. Whilst such dates still need refining and may change through further detailed analysis, the archaeological investigations reaffirm that we do not yet know the full story of the monuments of the Kathmandu Valley. The dates provided in epigraphs and chronicles provide only a partial picture of the history and development of the historic sites of these cities and further archaeological investigations are required, especially with a focus on subsurface heritage to fully understand the origins and histories of these sites of Outstanding Universal Value. Furthermore, in tandem with material analysis, archaeological assessments at the Vatsala Temple and across Bhaktapur, within the Durbar Square and surrounding localities, could provide a case study for sustainable development, rehabilitation and reconstruction utilising traditional techniques, whilst also preserving the surviving subsurface and standing archaeological heritage of this historically important site.

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Figures

Figure 1: Silu Mahadev, or Fasu Dega (Tahacho Dega) Temple photographed in November 2015.

Figure 2: Earthquake damage in Bhaktapur's Durbar Square.


Figure 3: The Vatsala Temple before the 2015 earthquake.


Figure 4: The collapsed Vatsala Temple on surviving plinth.

Figure 5: General view of Trench 1, looking south over the Durbar Square.

Figure 6: Post-1934 earthquake herringbone patterned pavement in Trench 1.

Figure 7: Wall alignments running east-west across Trench 1, looking north.

Figure 8: Masonry features running north-south across Trench 1, looking west. Also note the modern pipelines running across the trench in the foreground.


Figure 9: Brick paved surface in Trench 1, looking east.

Figure 10: Shear crack of wall within Trench 1 indicating possible earthquake damage.

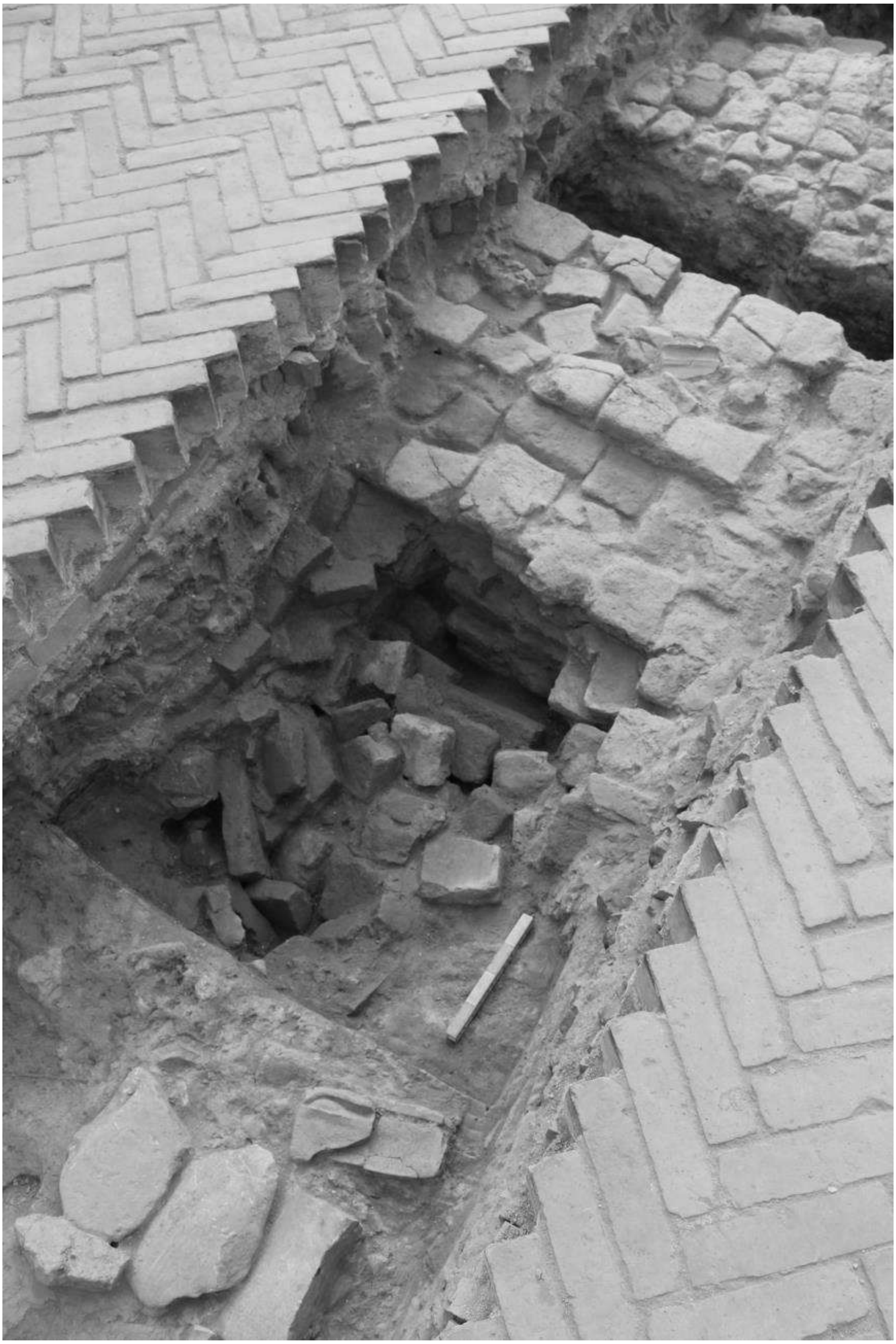

Figure 11: Wall collapse in Trench 1, indicating possible earthquake damage, looking south west.


Figure 12: Brick features within a cut in Trench 1, possibly relating to a drain, looking south.

Figure 13: Later brick courses overlying earlier footprint of the Vatsala Temple at the south-west corner.


Figure 14: Surkhi deposit within cut adjacent to the Vatsala Temple in Trench 1A.

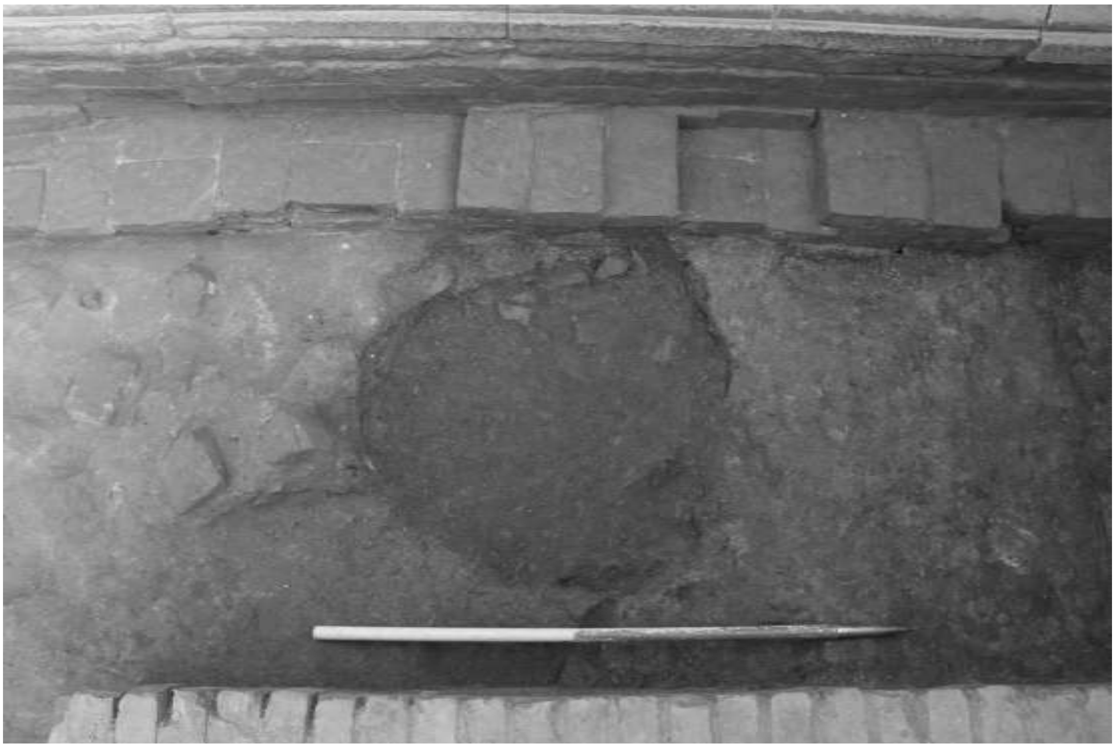
Figure 15: Brickdust deposit within cut adjacent to the Vatsala Temple in Trench 1A.

Figure 16: Pit feature with large stone resting on brick packing in Trench 1A, looking south.

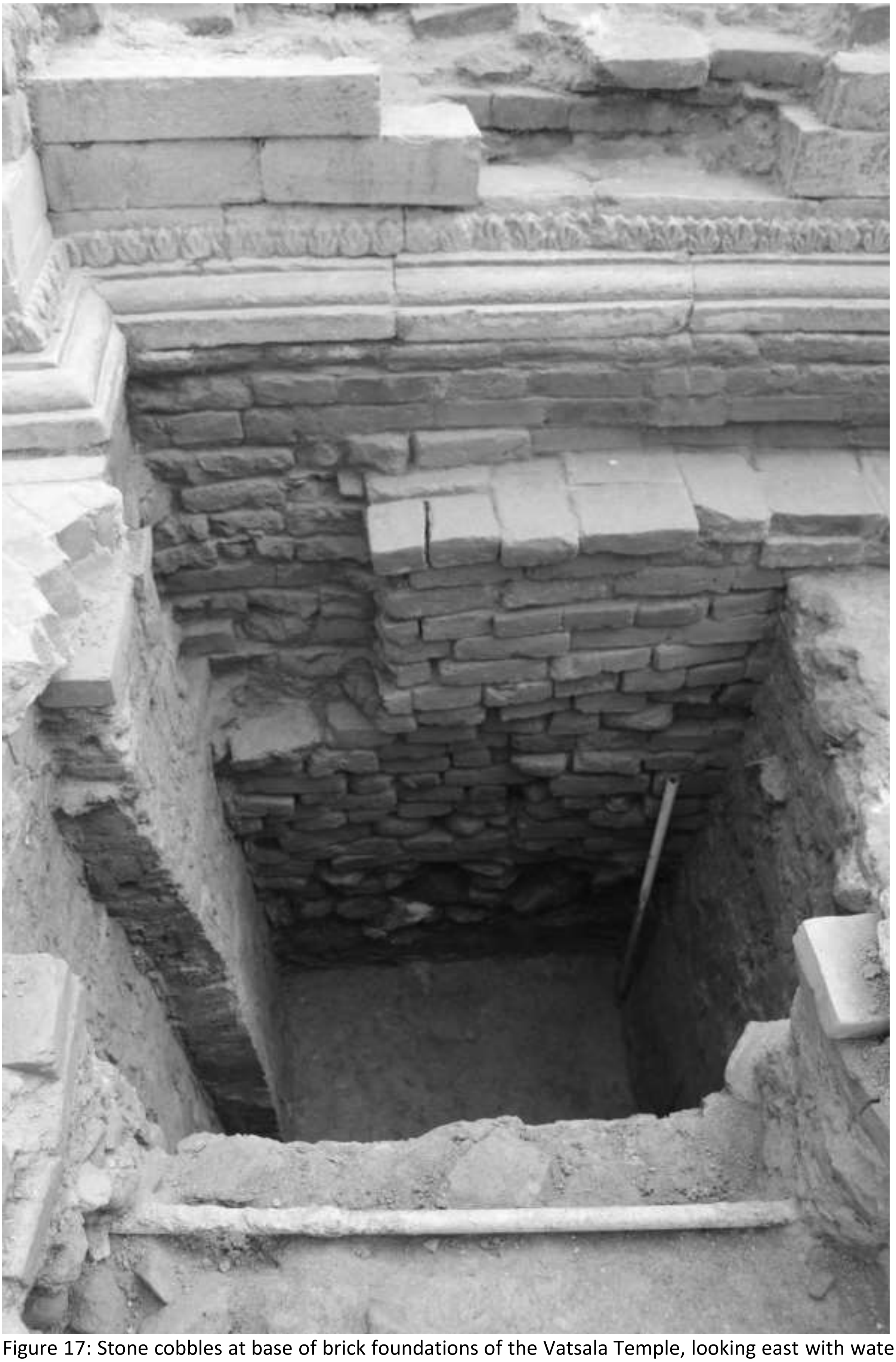

Figure 17: Stone cobbles at base of brick foundations of the Vatsala Temple, looking east with water pipe at base.


Figure 18: Detail of stone cobbles at base of foundations of the Vatsala Temple.


Figure 19: Differing phases of construction and bonding of brick and stone block masonry in Trench 1B.

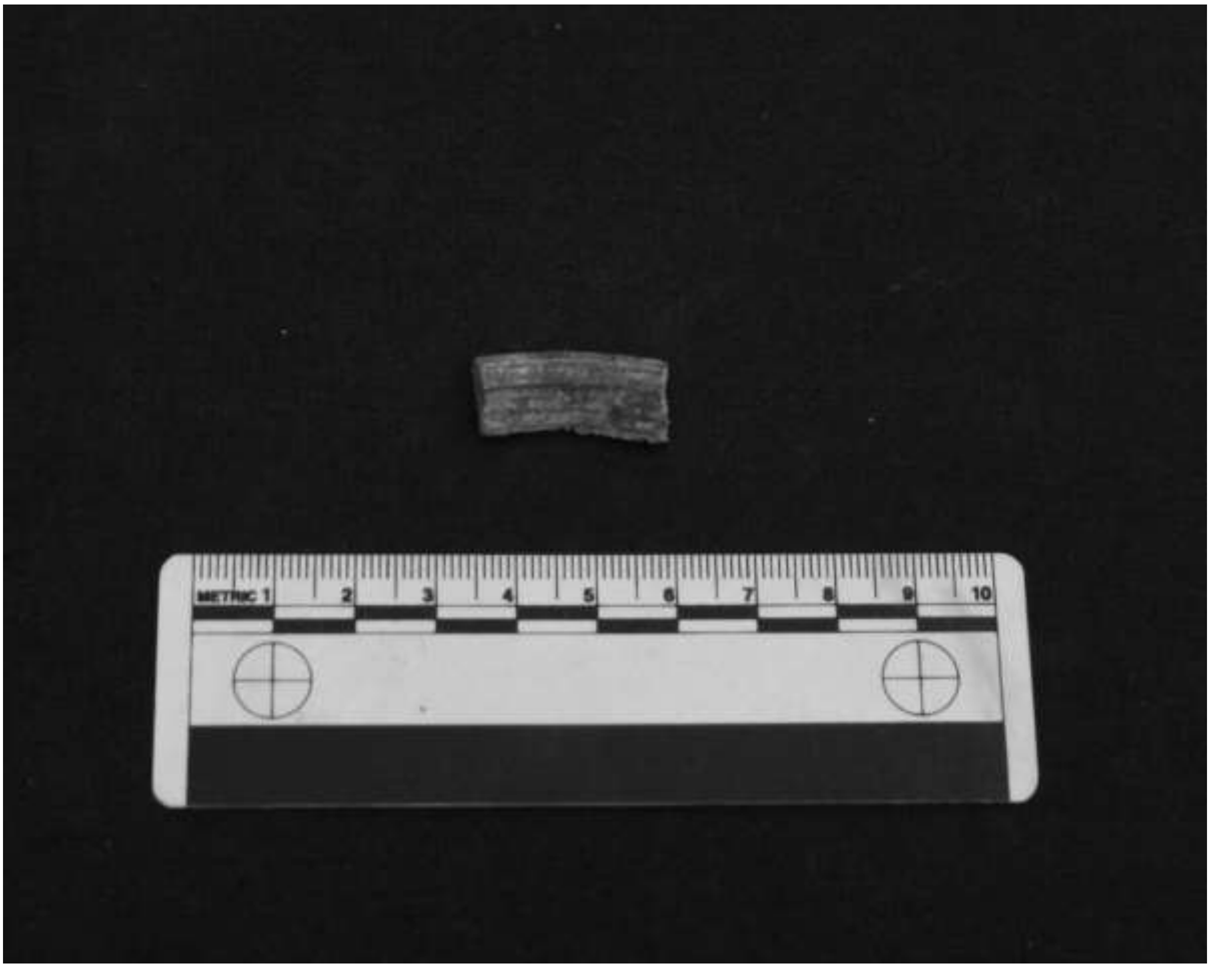

Figure20: Fragment of copper alloy bell rim, found during excavation in Trench 1B.

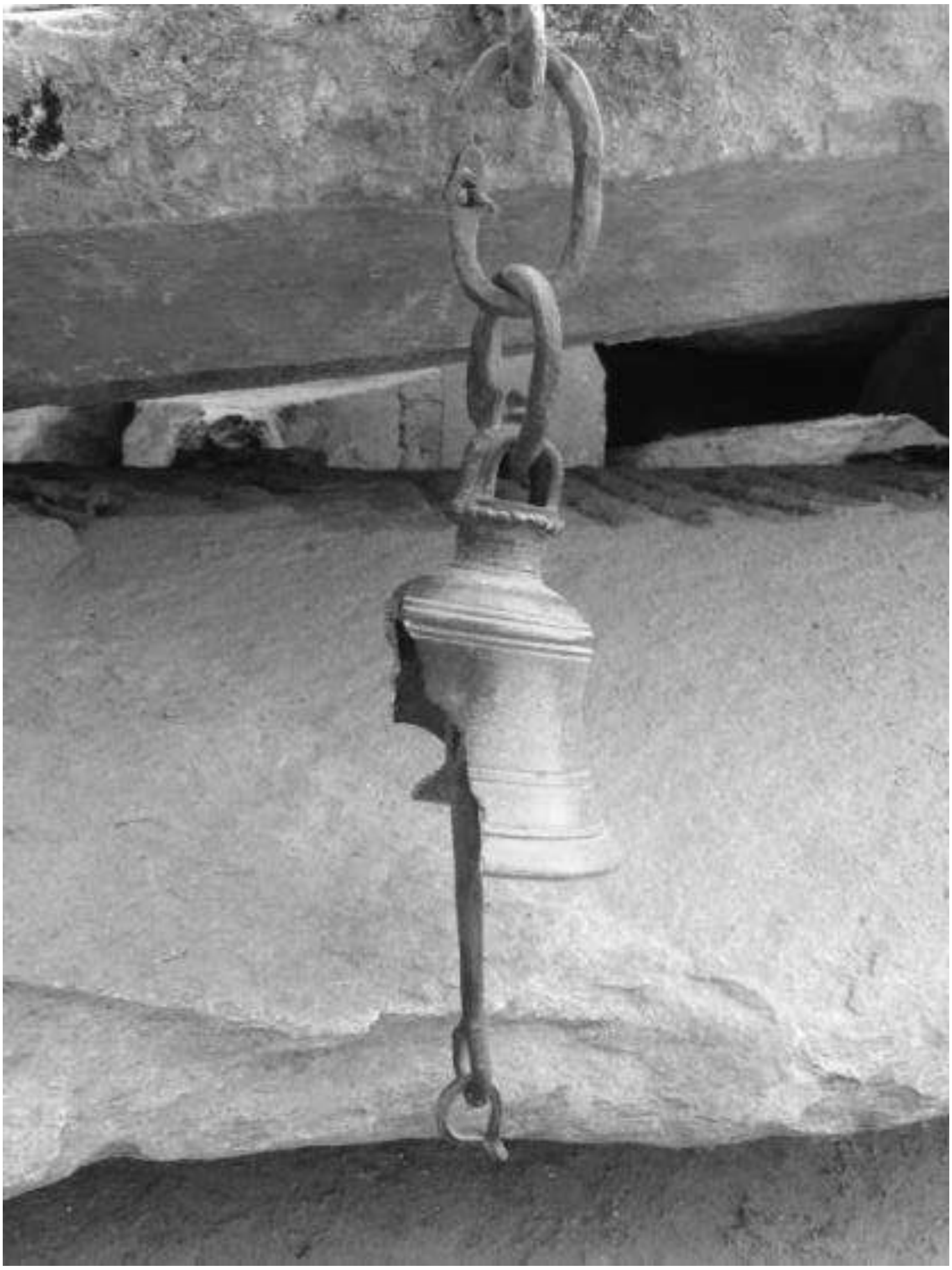

Figure 21: Copper alloy bell from debris of the Vatsala Temple.

Figure 22: GPR survey being conducted in Bhaktapur’s Durbar Square.

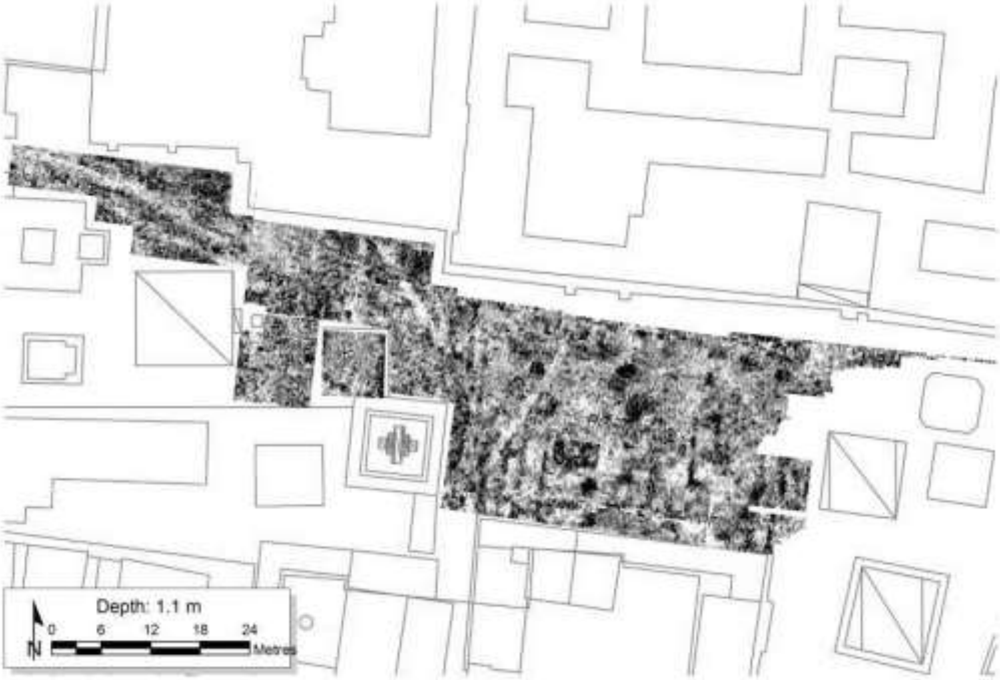

Figure 23: GPR results across Bhaktapur’s Durbar Square at a depth of 1.1 metres.

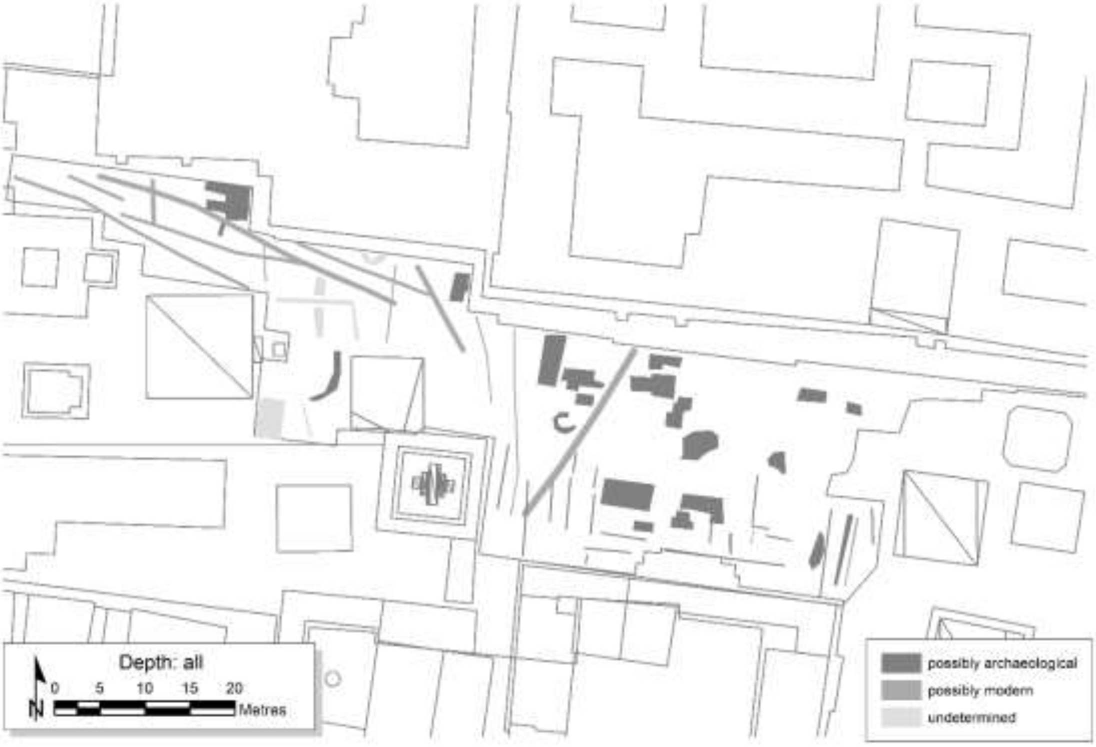

Figure 24: Interpretation of GPR results across Bhaktapur's Durbar Square.

Figure 25: Provisional Archaeological Risk Map for Bhaktapur's Durbar Square.

Figure 26: Different phases of subsurface wall alignments represented through differing brick patterns at the site of Jarrow, United Kingdom.

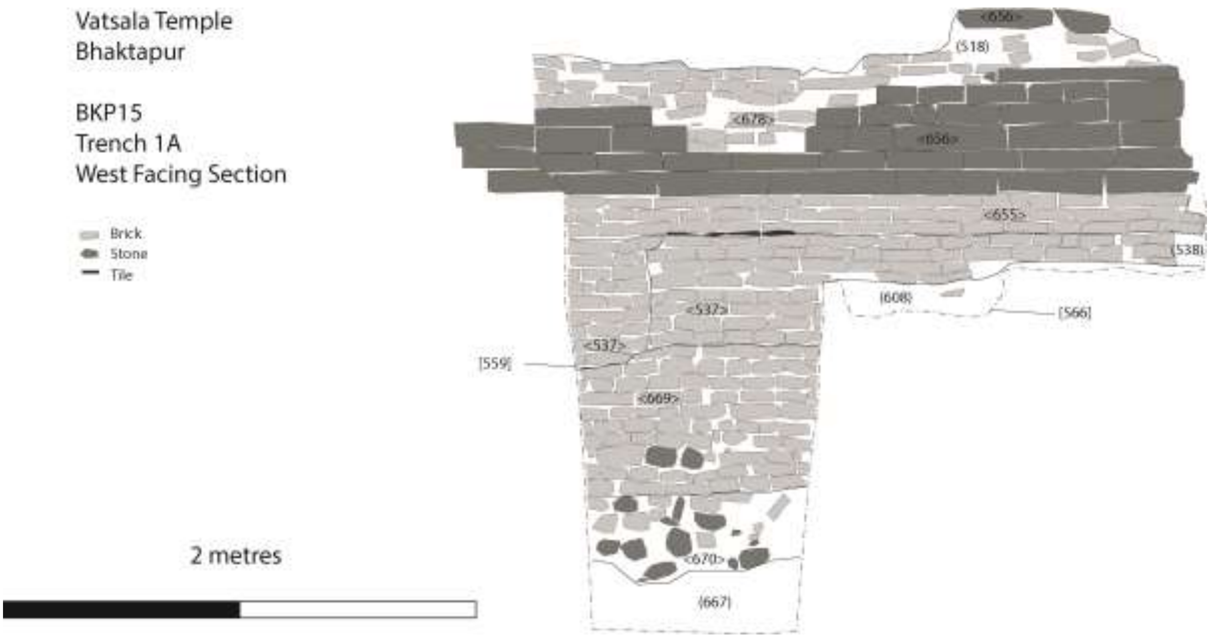

Figure 27: West facing section of Trench 1B.

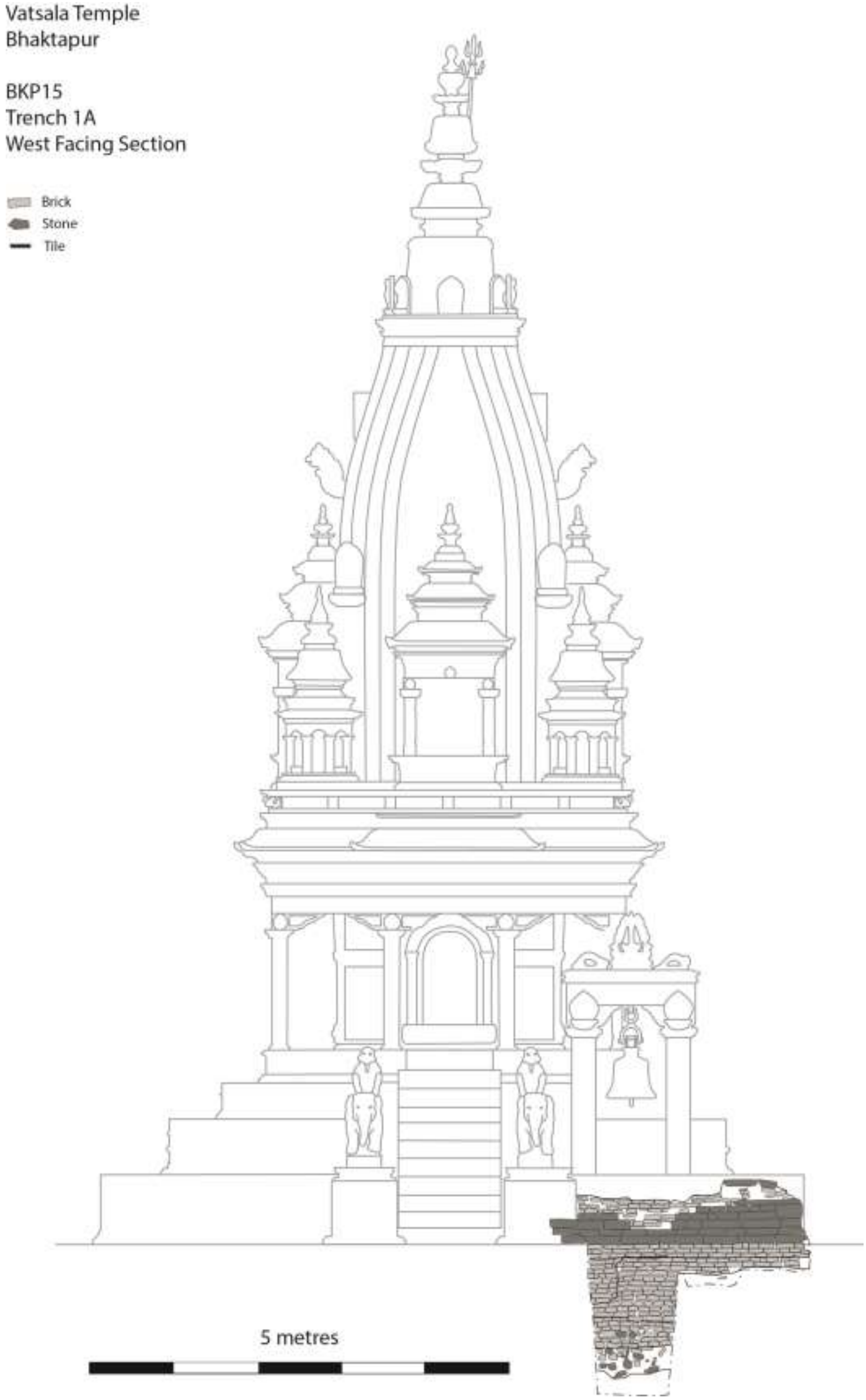

Figure 28: West facing section of Trench 1B, illustrating depth of foundations, with superimposed elevation of Vatsala Temple before collapse (Elevation of Vatsala Temple after Basukala et al. 2014).